Quantum state engineering and entanglement manipulation with linear optics

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Quantum information processing (QIP) is based on state preparation, unitary operations and measurements. Linear optics toolbox, which includes beamsplitters, polarizing beamsplitters, phase shifters, auxiliary modes, and conditional measurement, has received much attention in QIP implementations. The two main areas where linear optics toolbox is commonly employed are (i) the generation of optical qubit states, such as arbitrary superposition of Fock states, and the manipulation of those states by quantum gates constructed again with linear optics, and (ii) entanglement manipulation. Entanglement which is considered as one of the most important resources in QIP schemes, such as teleportation, dense coding and entanglement based cryptography, is very susceptible to decoherence and dissipation during its generation, storage and distribution. Entanglement distillation and concentration schemes have been proposed to extract M pairs of more-entangled pairs from N (N>M) pairs of less-entangled pairs using local operations (applied individually on each pair or collectively on several pairs) and classical communication [1]. After briefly introducing the linear optics toolbox, we will show how this toolbox can be exploited for state generation and gate construction in very simple schemes [2,3,4] and then focus on how the entanglement distillation/concentration can be achieved using this toolbox. The results of our recent experiment [5], which is the first demonstration of entanglement distillation/concentration by collective manipulation of two less-entangled photon pairs, will be presented, and the problems in the use of linear optics toolbox for QIP will be discussed.

References

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